Nova Note 701

Creep rate versus stress

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Abstract
We provide first comments on the recent report on PVC creep provided by Ray Harrell to ANL . The existence of a single "creep modulus", independent of stress, is not supported by our creep data.

The report "Modeling of the Creep Modulus . . .", prepared for ANL and NOVA by E. Ray Harrell,Jr on March 3, 2006 ,
tries to predict long term creep behavior of our "PetB" PVC material for a 20 year exposure from data taken with test frequencies between m0.01 and 100 rad/sec, combined with viscoelastic theory.
One of the expectations is that there exist a "creep modulus" which describes the Stress/Strain ratio at all times. This is a testable hypothesis.
In the plot below I have plotted the strain rate (per decade of time) versus stress.
I have shown in another plot that the strain can be very well described as being proportional to the logarithm of time (see NOVA note 607).
If creep can be described by a single (not stress-dependent) creep modulus (time dependent), then the strain rate must be proportional to stress.
The plot below shows strain rates versus stress for Extrutech material and PetB material, and also a sample curve of stress-independent creep modulus (the yellow triangles).
The data for both materials are clearly best described by and exponential dependence of creep strain on stress (the straight lines) than the yellow triangles.

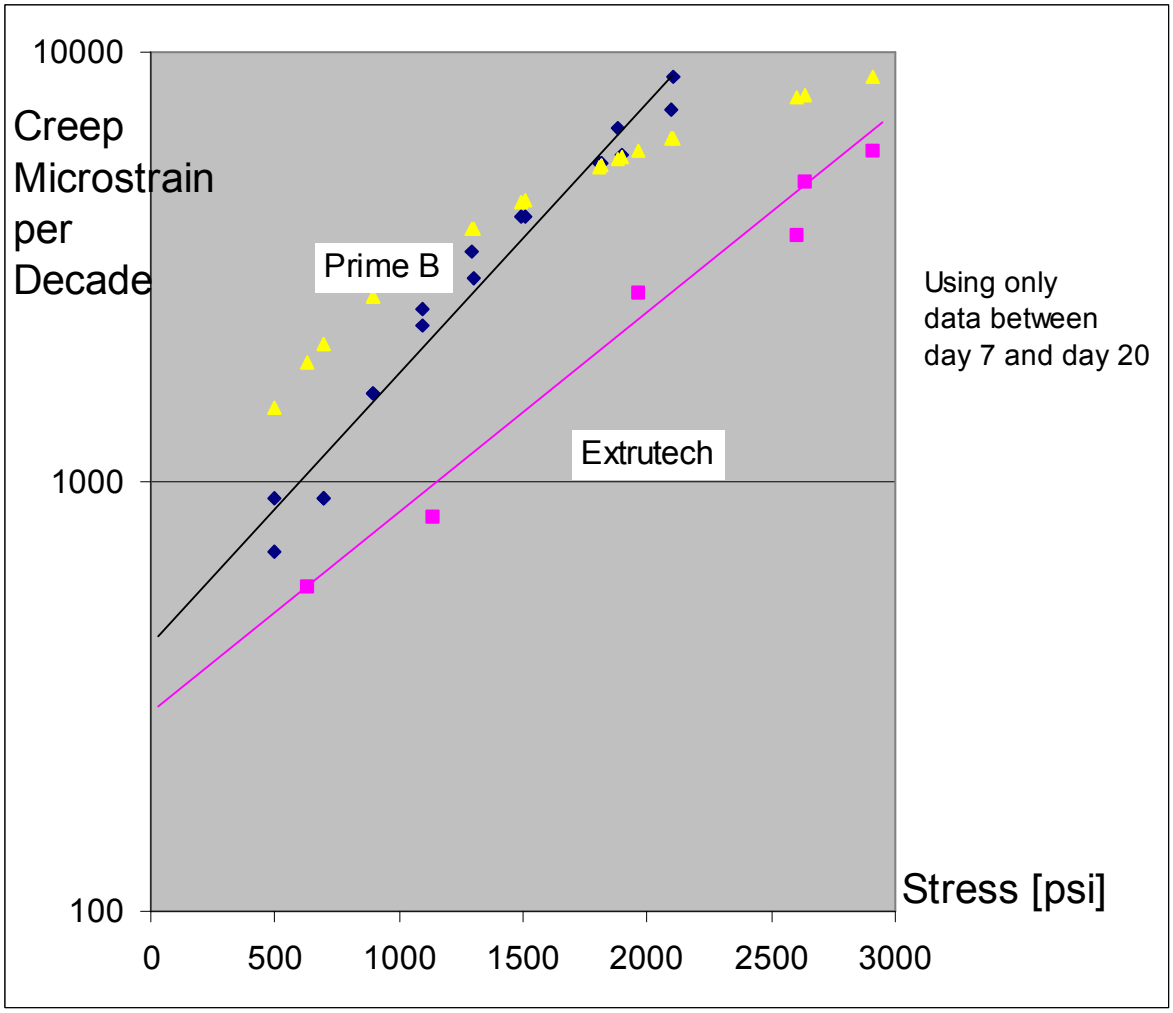
I asked the Fermilab Library to find the book by John Ferry that is the basis of the viscoelastic analysis used by Mr.Harrell.

Initial concerns are:
The theory is valid only "near and above the glass transition temperature"
The theory takes data taken "over 3 decades of frequency" and extends them to "15 decades by the FTS method"
The derived density (Fig.6) dependence is completely wrong. The author fixes that by setting beta=zero.
The piece-wise assembly of the master curve (Fig 7) from shifted data is less than convincing. Every instance of the input data is in significant shape disagreement with the master curve.

More after I get the book.

Sincerely

Hans


10000
Creep
Microstrain
per
Decade
1000
100
Prime B
Extrutech
Using only
data between
day 7 and day 20
Stress [psi]
0
500
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1500
2000
2500
3000